Electronic Supplementary Information

Self-assembly of functionalized Echinops-like Rh porous nanostructure electrocatalysts for high efficient seawater splitting

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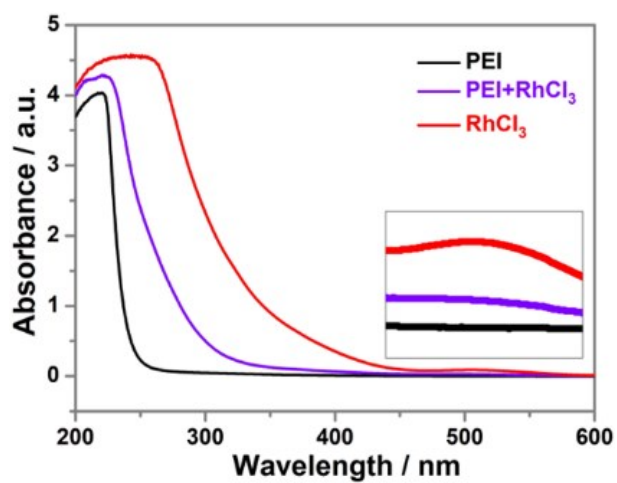# Figure

Fig. S1. UV−vis absorption spectra of PEI, RhCl$_3$, and PEI+RhCl$_3$ solution.
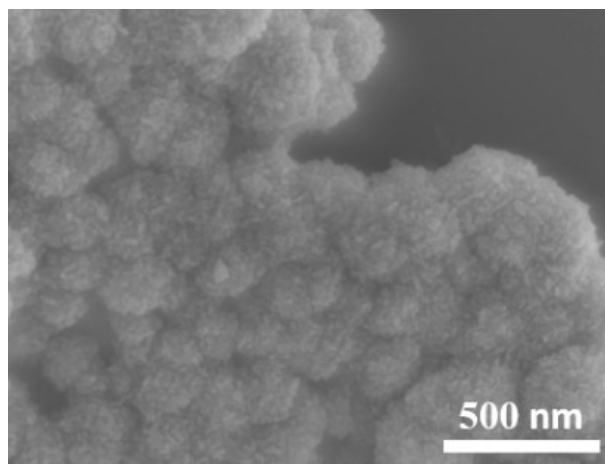

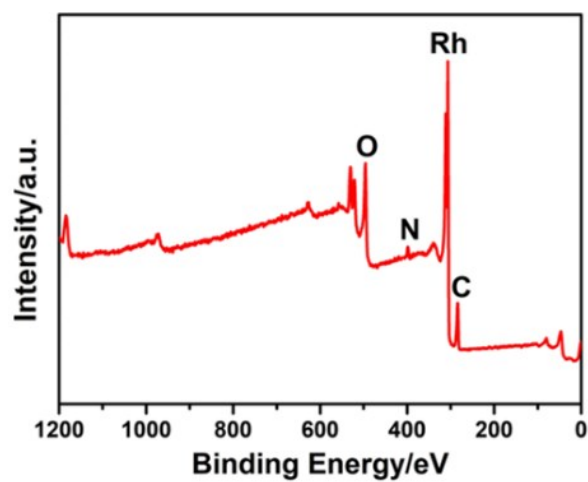**Fig. S2.** SEM image of Echinops-like Rh PNNSs.

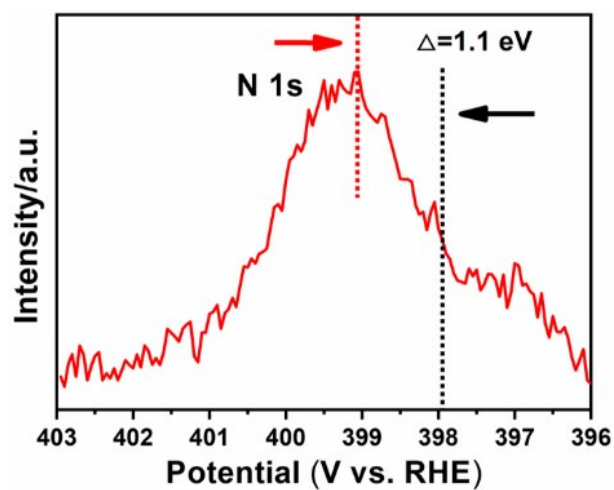**Fig. S3**. XPS full spectrum of Echinops-like Rh PNNSs.

Fig. S4. N1s XPS spectra of Echinops-like Rh PNNSs.
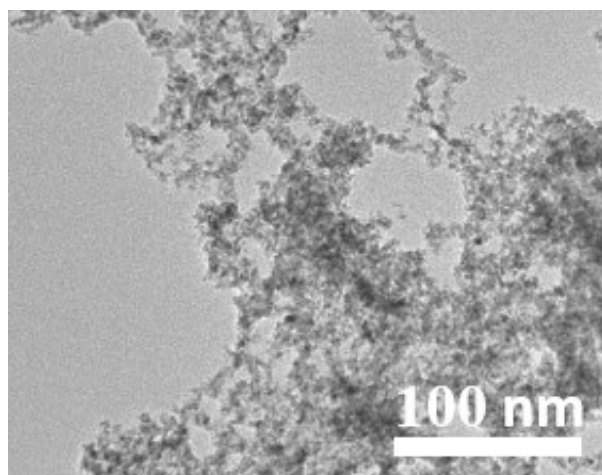

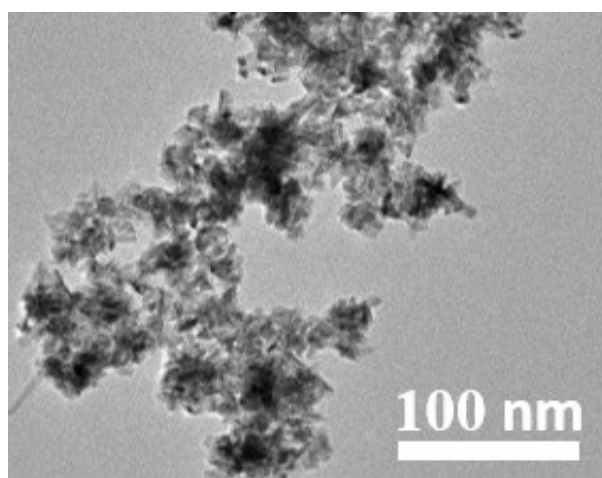
Fig. S5. TEM image of Rh nanostructures without PEI.

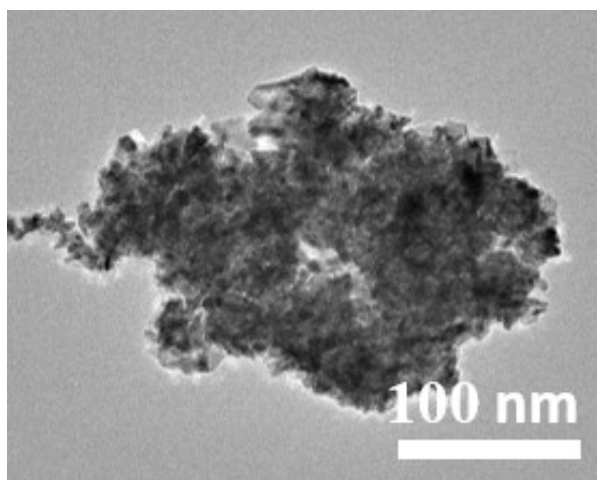**Fig. S6.** TEM image of Rh aggregate synthesize with PEI 10000.

Fig. S7. TEM image of Rh aggregate synthesize by hydrothermal method.
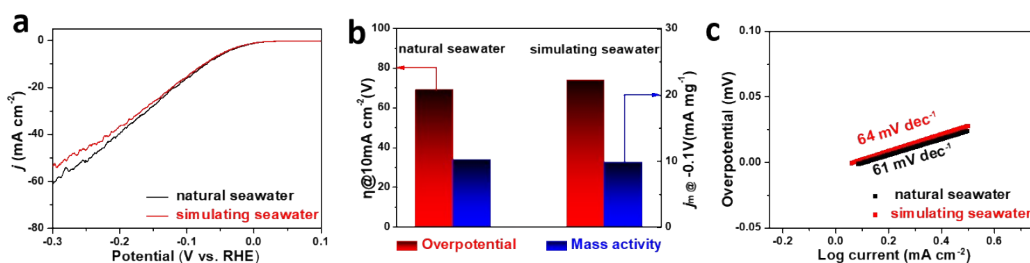

Fig. S8. (a) HER polarization curves of Echinops-like Rh PNNSs in the electrolyte of simulating seawater and natural seawater at a scan rate of 5 mV s^{-1}, (b) comparison of overpotential to drive a current density of 10 mA cm^{-2} and mass-specific activity (jm) at −0.1 V (vs. RHE) in simulating seawater and natural seawater, and (c) corresponding Tafel plots.
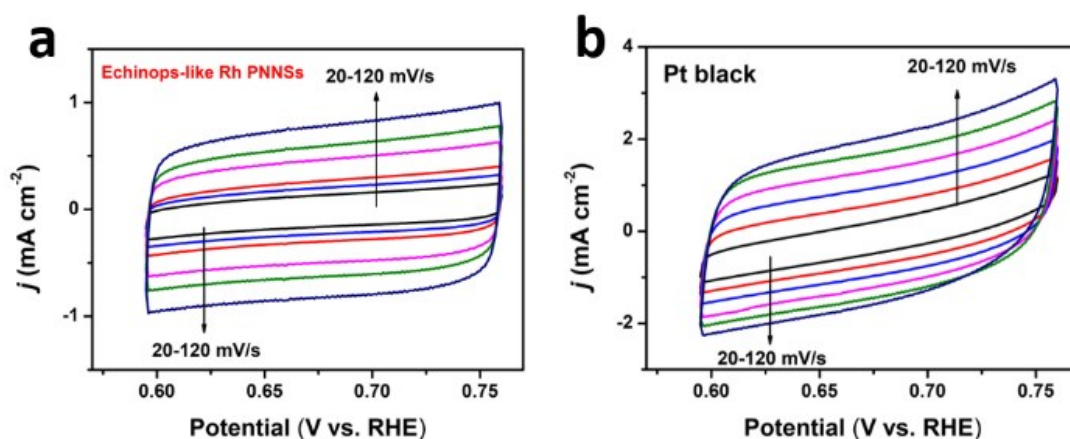

Fig. S9. Cyclic voltammograms of (a) Echinops-like Rh PNNSs and (b) Pt black in the region of 0.6-0.75 V vs RHE at the scan rates of 20, 40, 60, 80, 100, 120 mV/s.
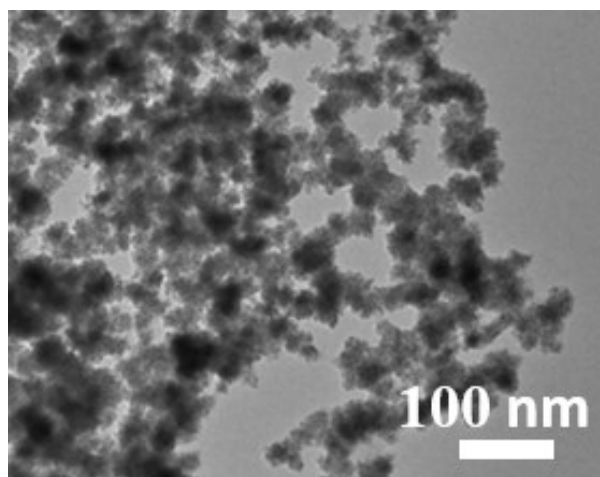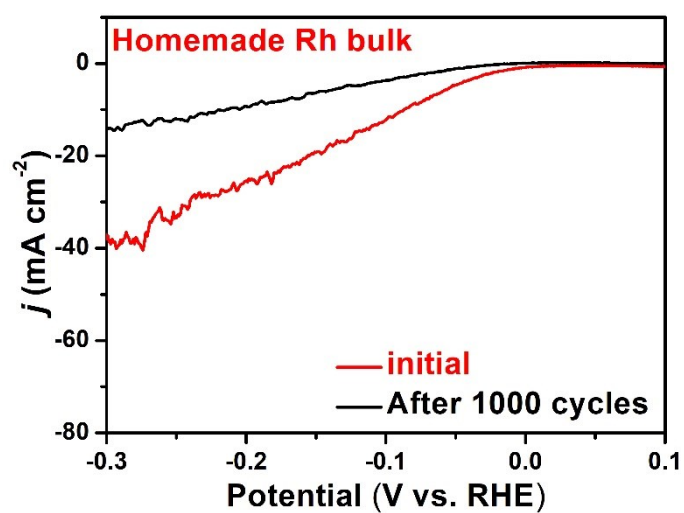
Fig. S10. The TEM image of homemade Rh bulk.

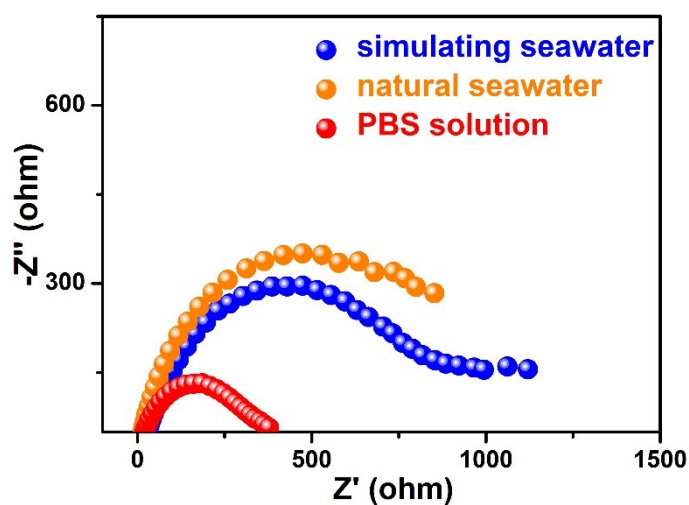**Fig. S11.** HER polarization curves of homemade Rh bulk before and after 1000 cycles.

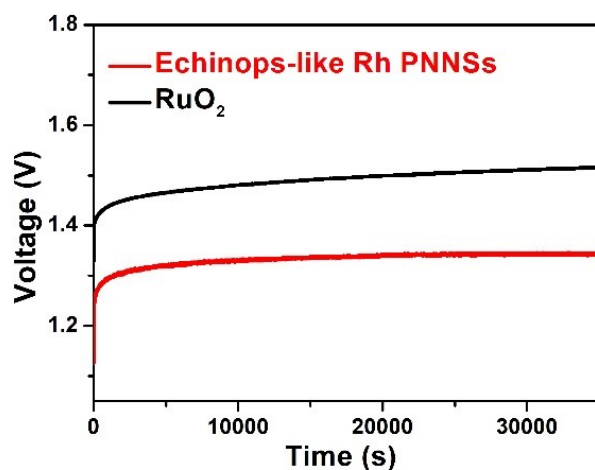**Fig. S12.** EIS spectrum of Echinops-like Rh PNNSs in 1.0 M PBS solution, simulating seawater, and natural seawater.

Fig. S13. Chronopotentiometry curve of Echinops-like Rh PNNSs and RuO_2 for OER without iR compensation.
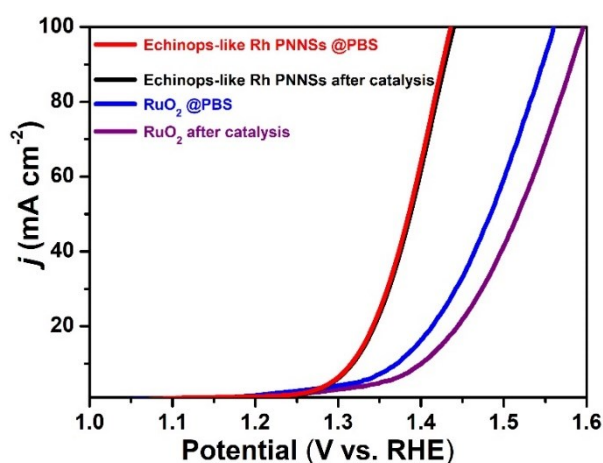

Fig. S14. OER polarization curves of Echinops-like Rh PNNSs and commercial RuO_2 before and after long-term continuous tests in 1.0 M PBS solution.
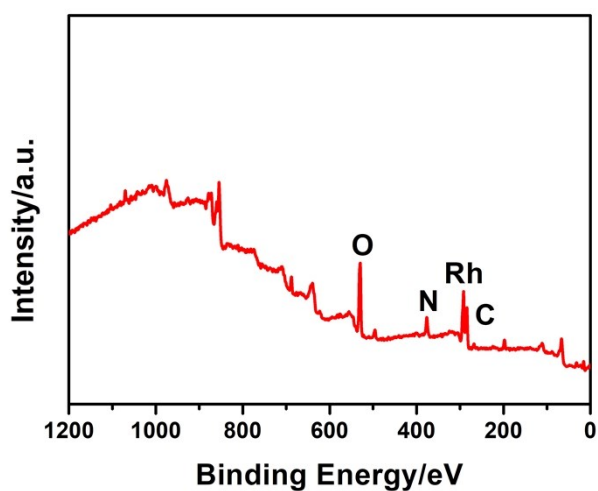

Fig. S15. XPS full spectrum of Echinops-like Rh PNNSs after long-time durability at the anode.
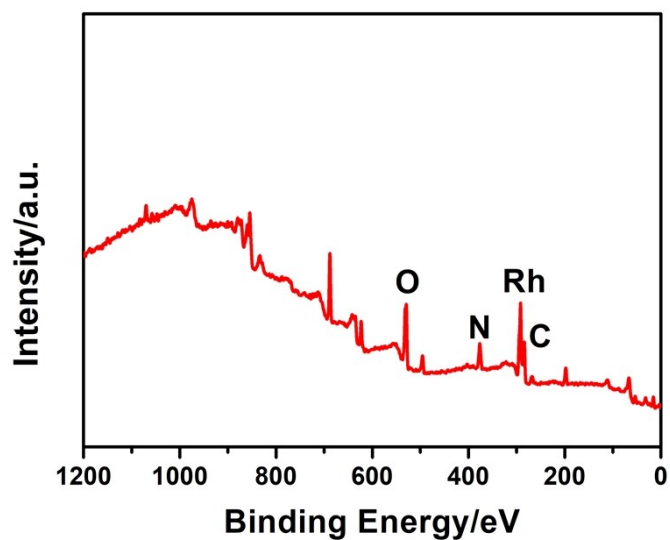
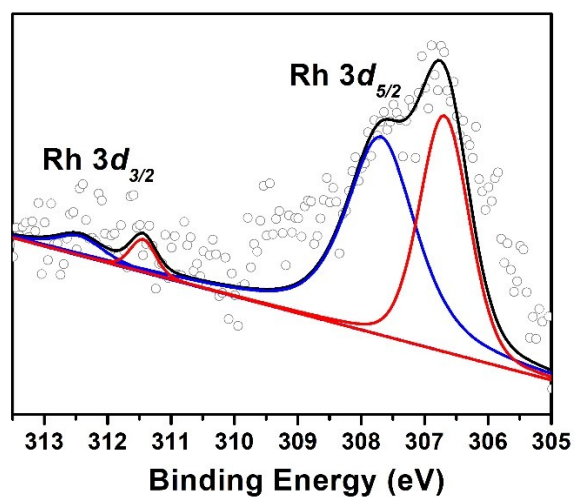**Fig. S16.** XPS full spectrum of Echinops-like Rh PNNSs after long-time durability at the cathode.

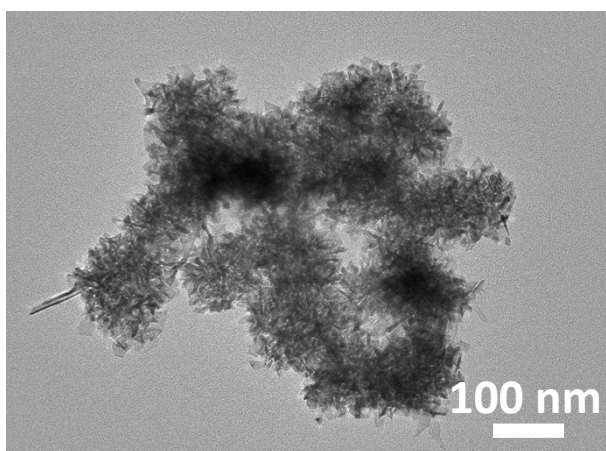**Fig. S17.** XPS spectra of the oxidation of metallic Rh on the surface of Echinops-like Rh PNNSs

Fig. S18. TEM image of Echinops-like Rh PNNSs after long-time durability at the anode.
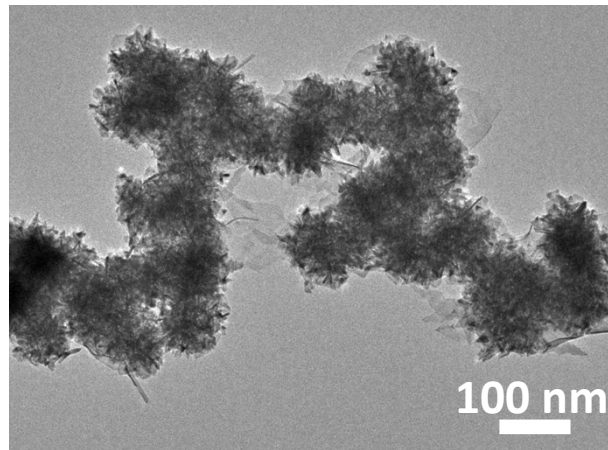
Fig. S19. TEM image of Echinops-like Rh PNNSs after long-time durability at the cathode.